

CLAIMS

1. A photomultiplier comprising:

an enclosure having an inside kept in a vacuum state, said enclosure whose at least part is constructed by a glass substrate having a flat part;

a photocathode, accommodated in said enclosure, emitting photoelectrons to the inside of said enclosure in response to light captured through said enclosure;

an electron multiplier section, arranged on a predetermined area of the flat part in said glass substrate, for multiplying in a cascading manner the photoelectrons emitted from said photocathode; and

an anode, arranged on an area excluding the area where said electron multiplier section is arranged on the flat part in said glass substrate, for taking out electrons having arrived thereat among electrons multiplied in a cascading manner in said electron multiplier section as a signal.

2. A photomultiplier according to claim 1, wherein said enclosure comprises a lower frame comprised of a glass substrate; an upper frame opposing said lower frame; and a side wall frame, provided between said upper frame and said lower frame, having a form surrounding said electron multiplier section and said anode.

3. A photomultiplier according to claim 2, wherein said electron multiplier section and said anode are arranged on the flat part in said glass substrate while in a state separated by a predetermined distance from said side wall frame constituting a part of said enclosure.

4. A photomultiplier according to claim 2 or 3, wherein said

side wall frame is comprised of a silicon material.

5 5. A photomultiplier according to one of claims 2 to 4, wherein said upper frame is comprised of one of a glass material and silicon material.

 6. A photomultiplier according to one of claims 1 to 5, wherein said electron multiplier section is comprised of a silicon material.

 7. A photomultiplier according to one of claims 1 to 6, wherein said anode is comprised of a silicon material.

10 8. A photomultiplier according to claim 1, wherein each of said electron multiplier section and said anode is comprised of a silicon material, said electron multiplier section and said anode being fixed to the flat part in said glass substrate by one of anodic bonding and diffusion bonding.

15 9. A photomultiplier according to claim 2, wherein each of said electron multiplier section, said anode, and said side wall frame is comprised of a silicon material, said electron multiplier section, said anode, and said side wall frame being fixed to the flat part in said glass substrate by one of anodic bonding and diffusion bonding.

20 10. A photomultiplier according to claim 4 or 9, wherein said upper frame is comprised of a glass material; and

 wherein said upper frame is joined to said side wall frame by anode bonding or diffusion bonding such that said upper frame and said lower frame sandwich said side wall frame therebetween.

25 11. A photomultiplier according to claim 5, wherein said upper frame has a transmitting window for taking light into said enclosure.

12. A photomultiplier according to claim 4 or 9, wherein said side wall frame has with a transmitting window for taking light into the enclosure.

5 13. A method of manufacturing the photomultiplier according to claim 2, said method comprising the steps of:

preparing a lower frame, comprised of a glass material, constituting a part of said enclosure;

10 preparing a side wall frame constituting a part of said enclosure, said side wall frame being formed together with said electron multiplier section and said anode by etching a single silicon substrate;

preparing an upper frame constituting a part of said enclosure; and

15 fixing said side wall frame to said lower frame together with said electron multiplier section and said anode by one of anodic bonding and diffusion bonding.

20 14. A method of manufacturing a photomultiplier comprising an enclosure constructed by a lower frame, a side wall frame, and an upper frame, while having an inside kept in a vacuum state, a photocathode accommodated in said enclosure, an electron multiplier section accommodated in said enclosure, and an anode at least partly accommodated in said enclosure, said method comprising the steps of:

preparing a lower frame, comprised of a glass material, constituting a part of said enclosure;

25 preparing a side wall frame, comprised of a silicon material, constituting a part of said enclosure;

preparing an upper frame constituting a part of said enclosure;

and

fixing said side wall frame to said lower frame by one of anodic bonding and diffusion bonding.

15 15. A method according to claim 13 or 14, wherein said upper frame is comprised of a glass material; and

wherein said upper frame is joined to said side wall frame by one of anode bonding and diffusion bonding such that said upper frame and said lower frame sandwich said side wall frame therebetween.

10 16. A method according to claim 13 or 14, wherein said upper frame is comprised of a silicon material; and

wherein said upper frame is joined to said side wall frame by one of anode bonding and diffusion bonding such that said upper frame and said lower frame sandwich said side wall frame therebetween.

15 17. A method according to claim 13, 14, or 16, wherein said upper frame is formed with a transmitting window for taking light into said enclosure.

18. A method according to claim 13, 14, or 16, wherein said side wall frame is formed with a transmitting window for taking light into said enclosure.